given in the same Number of the 'Annals') may be characteristic of certain orders. If we confine the word raphides to the needle-like crystals commonly occurring in bundles, it may be the expression of a more universal diagnosis between such orders as Onagraceæ and their next allies, and yet not less simple and sure, than any single character hitherto employed. Thus, too, we could determine the affinities and contrasts of certain plants by a method at once easy, novel, and practical, and all this in the absence of those parts heretofore exclusively used for the descriptive distinctions. And there would be another advantage in enlisting these crystals into the service of systematic botany; for we should not be thus employing merely an empirical formula, but methodically recognizing some really fundamental results of plant-life, well fitted to keep before us such interesting and important phenomena in the economy of vegetation as must be especially valuable in a natural system of classification.

Still these observations are only offered suggestively, and not dogmatically, in the hope of exciting such further research as may yet be required either to extend, confine, or correct them, —since I have had so little opportunity of examining numerous species, that it is desirable that other botanists who may be more favourably situated will continue the inquiry, especially as regards exotic plants.

Edenbridge, August 17, 1863.

XXIX.—*On the Part played by Deciduous Plants in the Tertiary Floras previous to the Miocene properly so called, and especially in that of the Gypsum of Aix.* By the Count Gaston de Saporta*.

The part played by deciduous plants, congeneric with those of Europe in the present day, in the Tertiary floras of a far-distant age is one of the most singular questions raised by the still modern study of the fossil plants of this period. The very existence of these plants, or, rather, the contrast resulting from their association with perfectly tropical forms, constitutes of itself a very remarkable phenomenon. We should in vain attempt to explain it by a cause analogous to those which are still in action. It is true that the supposition of an alpine region situated in the vicinity of the ancient deposits, sufficiently elevated and cold to cause the presence of these species, presents itself immediately to the mind as a natural hypothesis; and yet, when we consider that it is not only upon an isolated point, but constantly and in

* Translated from the Bibliothèque Universelle, March 1863, p. 186, by W. S. Dallas, F.L.S.

all the floras, starting from the *Upper Eocene*, that we meet with European forms (limited in number, it is true, but with remarkable fixity), we are compelled to see in them, not the result of an accident of locality, but one of the elements of the vegetation of that period—an element which must be taken into consideration in analyzing the totality from which it depends. The regular development of this same element, at first very slowly, constitutes the most salient feature of the Tertiary vegetation in its course towards modern times. We have not here to appreciate this progress, but to seize the true character of this group of species at its origin, when, far from predominating, it is, so to speak, lost in the midst of the most varied exotic forms. As they remove from their starting-point, the organisms (*essences*) with deciduous leaves tend progressively to become what they are at present; but, notwithstanding the chain which binds their present to their former state, it does not necessarily follow that their *mode of being* was the same at all times. It would be to draw a forced conclusion from what they are under our eyes if we pass beyond a simple analogy of form. The mere fact of their association with plants the presence and preponderance of which announce an order of things different from that which exists in our days is an important indication that these species were far from being then adapted to the external conditions to which their congeners are now subjected, and consequently that some difference must distinguish them from the similar organisms of the present day.

The existence of an annual temperature attaining an average of 68°–77° F. (20°–25° Cent.) at the time of the gypsum of Aix follows from all the indications furnished by the plants of the period. Nor is the successive diminution of the temperature less evident from the gradual disappearance of all the tropical forms—a disappearance which need not have taken place if these forms had originally been adapted to a ruder climate than that which is now necessary to them. In fact, if there is nothing in opposition to the assumption that the types which have since continued to be European were at first adapted to a hotter climate, the contrary supposition (that is to say, that of tropical types conformed to a colder climate) appears to be by no means admissible, not only because these types, from their organization, do not appear to be susceptible of such a deviation, but also because (leaving the possibility of this out of the question) their association, their mode of grouping, their preponderance, and their analogy with the most characteristic forms of tropical regions sufficiently indicate that the general vegetation of this epoch is the expression of a temperature sufficiently high, or at least sufficiently uniform, to give rise to the external conditions which are now characteristic of the countries near the tropics.

We might, indeed, suppose that the *Flabellariæ* of the gypsum of Aix, like the *Chamærops excelsa* lately planted in our gardens, were capable of bearing several degrees of cold without perishing, if these trees occurred isolated in the midst of a multitude of organisms of European physiognomy; but it would be contrary to all the data furnished by the study of the laws of nature to extend gratuitously the same supposition to the assemblage formed along with the Palms by the species of *Dracæna, Musaceæ, Myrica, Andromeda, Zizyphus,* and *Rhus,* of tropical physiognomy, the *Laurineæ, Bombacia, Anacardiaceæ, Cæsalpinieæ,* and *Mimoseæ,* of which the mass encumbers the vegetation of Aix, whilst the species with deciduous leaves, isolated and lost in the midst of the others, would hardly attract attention, if their analogy with their European congeners of the present epoch did not lead us, justly, to attach a very peculiar significance to their presence.

In any case, these plants were then only a very limited accessory; it is therefore more simple to inquire how these plants accommodated themselves to a climate which favoured the growth of all tropical forms than to assume that the climatic conditions were established for the smallest portion of the total vegetation.

Thus, therefore, if we accord to the period of the deposition of the gypsum of Aix and the beds immediately subsequent to it a climate hot enough to cause the presence of the tropical forms, this hypothesis, which is justified by the general facts, is at the same time the negation of a cold season sufficiently severe to produce, by this alone, the stripping of the organisms with deciduous leaves.

It is nevertheless easy to see that the Tertiary species analogous to those which now bear deciduous leaves present no difference from the latter in their consistence, aspect, or any other circumstance; so that we are justified in concluding, from the examination of this category of Tertiary plants, that they lost their leaves periodically in the same manner as the existing plants which reproduce the same model. To cite only the most striking examples, *Betula gypsicola, Populus Heerii, Cratægus nobilis,* and *Cercis antiqua,* in the flora of Aix, and *Betula ulnacea, Alnus prisca, Carpinus cuspidata,* and *Acer primævum* in that of Saint-Zacharie, are in this case; and if there be anything in the texture of their leaves to distinguish these ancient plants, it is a greater delicacy of tissue; so that it becomes probable that they bore leaves of a finer texture, traversed by nervures of much greater tenuity, than any of the modern species with which they are most nearly allied.

If the ancient temperature was sufficiently high to exclude the possibility of a cold season, and if, on the other hand, the

Tertiary plants congeneric with those of modern Europe lost their leaves, like the latter, at a certain period of the year, it is evident that we must seek for this periodical fall an original determining cause other than that of a diminution of temperature. It is true that we may, and that we even must, assume the existence of a season, not cold, but fresher and moister, succeeding to the hot season, reanimating vegetation instead of extinguishing it, and bringing on the flowering of the plants—a season rather of life than of sleep and death, and therefore very different from our winter. What might be the effects of such a season upon the plants which we believe to have had deciduous leaves is the problem which is now before us; but it is necessary, in the very first place, to ascertain whether cold—that is to say, the sinking of the thermometer below the degree of heat necessary to the vegetation of each species—is the actual cause of the interruption of this vegetation during winter, or whether this cold only serves to render this interruption longer, more complete, and more radical, by coinciding with the period at which it is naturally manifested.

Now, when set in these terms, the question is easily solved. It is evident that all trees suffer from thermometric cold. For those of our continent this cold is a crisis which they pass through at a moment when their organs are in a condition to offer it the most resistance. The sleep in which they are sunk, at the same time that it favours the internal elaboration of their organs, allows them to undergo the crisis of cold without inconvenience; but this crisis, it must be said, is neither the reason for the existence nor the true cause of their physiological condition, as may easily be proved. We may, in fact, lay down as a principle, that, in the very great majority of cases, the trees with deciduous leaves lose their leaves at a higher temperature than that which subsequently causes the evolution of new leaves. This phenomenon may be easily proved in southern countries, and even in Provence; it becomes very striking in the hot regions which permit the growth of tropical organisms side by side with those which are peculiar to the northern parts of our hemisphere. In Madeira, for example*, where, in consequence of a very great uniformity of temperature, there is scarcely any winter, the vegetation, taken in its totality, is never interrupted. A multitude of plants, and especially the *Laurineæ*, *Myrtaceæ*, *Passifloræ*, *Bignoniaceæ*, &c., both indigenous and exotic, blossom during this season, which is that in which the gardens present the most ravishing spectacle. Nevertheless this continuous mildness of the temperature is no obstacle to the progress of

* This observation is due to M. Heer, who resided for a considerable time in Madeira.

European plants; the poplars, willows, alders, and maples behave just as they do in Europe; and the contrast between the verdure and the flowers of the indigenous or tropical plants and the naked aspect of the European trees is not one of the least astonishing spectacles presented by the flora of this island. We may say, with justice, that the cold which, in northern countries, hastens the fall of the leaf, instead of being the true cause of this phenomenon, rather disturbs it in its regular course by accelerating it and rendering it sudden; whilst in temperate climates (and even in the south of France), where, in consequence of an almost insensible diminution of temperature, the physiological action is the only one manifested, the denudation of the trees with deciduous leaves takes place with a regularity which clearly shows the real tendencies of each species—so that, instead of assisting in that shower of leaves which denudes the branches in so short a time in central and northern Europe, each species parts with its leaves in its turn with more or less rapidity, in obedience to aptitudes equally diverse with the specific differences themselves.

Thus, the absence of thermometric cold, far from depriving plants with deciduous leaves of their true character, really restores it to them. It leads us to recognize in them what they really are—namely, trees whose leaves, being limited to a duration of a few months, tend to separate from the branch as soon as the latter possesses formed buds, organs into which the sap flows, abandoning the leaves to elaborate the rudiments of new organs destined to become developed after an interruption of variable length according to the species.

In fact, the fall of the leaves in plants in which they are deciduous is not always the sign of a complete sleep, but rather the occasion of an intermittence of vegetation; and for many genera, such as *Alnus, Betula, Corylus, Ulmus, Populus,* &c., of which we have to note the characteristic presence during the Tertiary epoch, this state is only, so to speak, the signal of the floral evolution which is accomplished in the absence of the leaves. The cold of our countries only opposes, retards, or even interrupts the flowering of those trees which, when transported into a milder climate, expand their flowers towards the end, or even in the depth, of winter. Here, again, the thermometric cold, far from coinciding with the phenomenon, arrests or confuses its phases by its occurrence, and especially by its irregular return.

The plants of which we are speaking are in reality in the same circumstances as many tropical organisms the flowering of which constantly takes place in the absence of the leaves, one portion of the year being devoted exclusively to the evolution of

leaves, and the other to that of flowers. It is thus that we must conceive the position of the deciduous plants at an epoch when the seasons were far from being regulated as they are at present. Their existence only apparently contrasts with that of the exotic plants with which they are associated; this disparity is effaced when we take into account, as we have just tried to do, what are these vegetable forms considered in themselves, abstracted from the changes to which they subsequently yielded more readily than the others. Their subsequent development and actual preponderance lead us to exaggerate their original importance, which in reality was very small. If afterwards it was otherwise—if the changes of temperature brought about by the lapse of time have contributed to increase the importance of these plants, this result (the effect of causes which were not yet in action at the epoch when we see them for the first time) must not lead us into error as to what they originally were. It is this first stage that we propose to analyze; and its knowledge will allow us to appreciate more justly the circumstances which subsequently brought about their multiplication correlatively with the exclusion of the forms which had previously predominated.

The frutescent plants with deciduous leaves and a European physiognomy, in the flora of the gypsum of Aix, amount to 15 at most, out of 118 dicotyledons. If from this number we deduct the more doubtful forms (those which present some analogy with living forms with persistent leaves, and those of which the leaves are still unknown), the number is reduced to 8 species only, that is to say, the insignificant proportion of 6·77 per cent. These species are the following:—

Betula gypsicola, Sap.	*Acer ampelophyllum,* Sap.
Ulmus plurinervia, Ung.	*Paliurus tenuifolius,* Heer.
Populus Heerii, Sap.	*Cratægus nobilis,* Sap.
Ribes Celtorum, Sap.	*Cercis antiqua,* Sap.

Nearly all these species belong to genera in which the flowers are often developed in the absence of the leaves, as in most of the *Betulaceæ*, *Ulmus*, many species of *Populus*, *Acer*, *Ribes*, *Cercis*, &c. It is probable that this was the case with the Tertiary species, and that their flowering coincided with the cool season, or that which took the place of winter, and during a portion of which these plants remained denuded of leaves as at present.

The most abundant of all these trees is the *Cercis antiqua*; all the others are excessively rare, or even unique. The *Cercis*, notwithstanding its identity with a genus now represented in Southern Europe, North America, and Japan, is not a characteristic type of the boreal zone. The living species of this genus

appear to be a last vestige of an ancient type on the point of disappearing, rather than an essential element of the vegetation of the north of the two hemispheres, as are the *Betulaceæ, Salicineæ, Cupuliferæ,* and *Ulmaceæ.* If we limit our remarks to these last groups, adding to the species above cited those which enter into the same category, such as *Alnus antiquorum,* Sap., and *Ostrya humilis,* Sap. (although the leaves of the former were no doubt persistent, like those of *Alnus nitida,* Spach, its Nepaulese analogue, and the involucra alone of the latter are known), we shall obtain a total of ten species actually representing the boreal element of the flora of the gypsum of Aix,—all these species, as has been said, being extremely rare in individuals. This rarity is the more remarkable because, if we consider the present importance of these organisms, and even that which devolved upon them in the latter half of the Tertiary period, they are amongst the most generally distributed species, for the natural reason that most of them, and especially the species of *Alnus, Populus,* and *Acer,* frequent the margins or the vicinity of water—a circumstance which must have favoured the preservation of their shed leaves.

To be convinced of this, all that is necessary is to glance through the principal fossil floras, starting from the true Miocene. *Betula Dryadum,* Brongn., in company with an *Acer,* has filled with its fruits and leaves the strata of Armissan (Aude). The two, no doubt, covered the Secondary slopes in the neighbourhood of the lacustrine basin in which are deposited the flags with impressions which are quarried in that locality. At Manosque *Alnus nostratum,* Ung., and *Carpinus grandis,* Ung., are amongst the commonest species. In the Swiss Mollasse deposits this is the case with the species of *Alnus* and *Carpinus,* and next with those of *Populus, Salix, Platanus,* and *Liquidambar*; at Œningen, *Populus latior,* A. Braun, and *Acer trilobatum,* A. Braun, are seen on every slab, in company with several species of *Salix.* Nothing is more natural than the abundance of these forms in reference to the present condition of things; but nothing is better established than their rarity as soon as we descend the series of beds and approach the Tongrian. At Saint-Zacharie* *Alnus prisca,* Sap., *Betula ulmacea,* Sap., and *Ostrya tenerrima,* Sap., are very thinly scattered; *Acer primævum,* Sap., and *Carpinus cuspidata,* Sap., are more abundant, but still much less so

* The actual age of this flora, at one time referred back by us, with doubt, to the Bartonian (see 'Recherches sur le Climat et la Végétation du Pays Tertiaire,' par O. Heer, traduit par C. T. Gaudin, p. 135), has since been found, after fresh explorations, to be less ancient than the gypsum of Aix, and not very distant from that of Hœring in the Tyrol, a Tongrian locality.

than the *Myriceæ*, *Proteaceæ*, and *Araliaceæ*, which abound in this deposit. The same rarity of European forms occurs also at Hœring, at Sotska, and at Mt.-Promina: the fact which we remark at Aix is therefore not isolated; it is related to circumstances which were uniformly repeated at the same epoch in all parts of Europe.

We are therefore led to this conclusion,—that the frutescent genera of European physiognomy, and particularly the *Betulaceæ*, *Ulmaceæ*, *Salicineæ*, and *Acerineæ*, were not then distributed as at the present day, and that they were destined neither to play the same part nor to mark in the same way the masses of the landscape.

What, then, was really the place occupied by these plants? On this subject there are but few suppositions to be made; and amongst these, one, no doubt, must express the truth.

It is nearly certain that, at the epoch of the gypsum of Aix, the species of *Alnus*, *Betula*, *Populus*, *Ulmus*, *Acer*, &c., did not inhabit the immediate vicinity of the ancient lacustrine shores. This part was reserved for species of Palms, *Coniferæ*, *Proteaceæ*, and *Laurineæ*; but we may, strictly speaking, remove the station devoted to the European forms of plants beyond the immediate margins, without by this excluding them from the neighbourhood of the waters. In fact, they may have adorned the banks of small streams, or the damp bottoms of the woods, or, lastly, cool and northern exposures, at a sufficient distance apart to prevent their shed leaves, &c., from being carried otherwise than exceptionally into the deposits in course of formation.

Nevertheless, if we admit this hypothesis as the true one, it brings with it many difficulties.

If the genera in question did really haunt the places which we should ascribe to them as their habitation, it is difficult to believe that they there formed great masses; for in that case their leaves, being transported by the winds or streams of water, would have reached the lake in comparative abundance, at least at certain times, although, no doubt, they would have left more scattered traces than the other species. It will be seen, in fact, that it is to a sort of chance alone that is due the preservation of an isolated species lost in the midst of others, whilst strong and numerous groups, notwithstanding distance, must have their leaves and fruits carried away with a certain regularity, and in such a way as to leave their impressions, perhaps not abundantly, but more or less repeated. Now we have seen that this is not the case with the species of European physiognomy belonging to the flora of Aix. The remarkable preservation of the impressions belonging to this category of plants is also opposed to our full adoption of this opinion. These impressions are very rare,

or even unique, in most cases, but they belong to very different organs. The fruit of the *Betula* occurs in a different stratum from that which contains the leaf. The fruit of the *Populus* has been found isolated from its leaf, and the latter separate from a ciliated bract, probably forming part of the same species. The involucra of *Ostrya* are not yet accompanied by their leaves; there exist a leaf of *Ulmus*, but hitherto no trace of its fruit, and leaves of *Acer* without any fruit. We must therefore notice a very great irregularity in the mode of transmission of the organs; and all that we can conclude from the state in which they have come down to us is, that no obstacle difficult to get over has stood in the way of their reaching the waters of the lake, that they did not get there from any great distance, and that small and delicate organs, especially those of fructification, have been preserved pretty frequently in a state of perfect integrity; whilst, on the other hand, winged fruits, easily carried by the wind, are sometimes wanting, in cases where the leaves have, on the contrary, passed into the fossil state.

What are we to conclude from these various observations, if not that the hypothesis first put forward as the most natural in appearance is at least contestable from the side of the facts? that these facts do not tend to confirm it, and would, on the contrary, rather lead one to think that the plants with a European physiognomy and deciduous leaves, although evidently excluded from the vegetable masses of the epoch, and forming arborescent groups of considerable size neither on the immediate margin of the waters nor in the vicinity of the ancient lake, do not appear nevertheless to have occupied a very distant station? and lastly, that their organs have reached the sediments in course of formation with complete irregularity, and without the aid of the wind having contributed to augment the proportion of such organs as the winged fruits, by assisting them to get over greater distances? It remains for us, therefore, to seek another series of hypotheses more in accordance with the facts.

Perhaps the plants in question, not possessing originally the appearance, size, and habits which they subsequently acquired, isolated in the midst of the robust plants of the period, only occupied a secondary place among them, which would explain at once their rarity as individuals and the limited proportional quantity of their organs, of which only a very small number could reach us.

On this hypothesis we should have to establish three points with regard to the plants under consideration:—(1) a sensible difference in their habitual station; (2) a peculiar mode of grouping, a natural consequence of the preceding, producing a greater rarity of individuals; (3) lastly, a comparatively small stature,—

circumstances all of which would have concurred to limit the quantity of organs fitted to pass into the fossil state.

The difference of station can only be proved by means of indirect negative evidence. It appears to be certain, however, that, as we have stated above, the plants nearest to the ancient lacustrine shores were not forms with a European physiognomy, but Palms, *Coniferæ*, *Proteaceæ*, *Zizyphi*, *Diospyri*, &c.—genera the impressions of which are met with in all the beds; and next to these, *Laurineæ*, *Ericaceæ*, *Leguminosæ*, &c., which usually make their appearance after the former. If the *Betulaceæ*, *Salicineæ*, *Ulmaceæ*, and *Acerineæ*, even in limited numbers, had inhabited the immediate margin of the ancient waters, their remains would have been buried annually, either at the period of the fall of the leaf or at that of the maturity of the fruit. Moreover it is the nature of plants inhabiting moist localities to multiply in colonies, in consequence of the uniformity of conditions, which uniformly favours the propagation of the same organisms; there is therefore, we repeat, but little probability (although nothing can be stated with absolute certainty) that the group of species of which we are speaking inhabited the zone immediately contiguous to the ancient shores; it is more natural to suppose that they were a little thrown back upon the second plane; but we remain of necessity in ignorance of their true aptitudes, not knowing the exact configuration of the ancient land. From stratigraphical observations, it appears that on one side (towards the north-east of the town) it was, if not commanded by escarpments, at least considerably elevated and broken. The repeated occurrence of *Coniferæ* (*Callitris*, *Juniperites*, *Widdringtinia*, *Pinus*) and of trees which, like *Cercis* and the *Proteaceæ* (*Grevillea*, *Lomatia*), haunted undulating ground rather than low and moist spots, must lead us to this opinion. On the other hand, the abundance of species of *Andromeda* and *Vaccinium* appears to indicate turfy and inundated ground, occupying probably a great extent. It is difficult to decide whether the organisms with deciduous leaves of the flora of Aix inhabited one or other of these two zones, and dwelt consequently upon the broken slopes or in moist, low, and marshy ground; the nature of the sediment in which their impressions are observed, and the kind of species with which they are associated in the beds, are the only indications which can be consulted in a question of this kind. The following are the notions which may be obtained upon this point.

There exist in the stratum of Aix two kinds of beds with vegetable impressions, indicating two modes of sedimentation, of different nature. The first includes schistose and especially marly limestones, in very thin laminæ, denoting a deposit formed

in calm waters, very feebly charged with a few particles of very fine mud. The vegetable impressions observed in these beds are due to organs which have either fallen in naturally, or been carried by the wind, or, lastly, transported into the lake by a very weak current of very clear water.

Other beds, on the contrary, are composed of deposits or strata of some thickness, either purely calcareous or composed of a whitish marly limestone, the body of which denotes an abundant mud, arising from the freshets which at certain periods exerted their action with more or less force upon certain points of the lake. They present vegetable impressions belonging to species which, in many cases, may have been carried for a considerable distance, or have arrived from other parts of the country, or at least have been entombed under different circumstances from the former.

It is therefore probable that the flora of the schistose beds is composed chiefly of the species living nearest to the ancient shore, or within a certain distance of it, and that it contains but few species brought from a distance, except perhaps seeds or light fruits. The flora of the marly beds, on the contrary, presents at once the littoral species and those brought by the muddy waters even from the interior of the country.

It may also be observed that the forest-trees of the genera *Quercus* and *Cinnamomum* and most of the *Anacardiaceæ* occur in those beds which also contain numerous *Andromedæ*. The leaf of *Ulmus plurinervia*, Ung., has likewise been met with in a marly bed.

The schistose beds contain rather the remains of the littoral plants, or of those which inhabited the neighbouring slopes and served as a cincture to the ancient lacustrine sheet on the eastern side. These are Palms, *Gramineæ*, *Coniferæ*, *Myricaceæ*, *Proteaceæ*, and a few *Laurineæ*, and, lastly, some *Rhamneæ* and *Leguminosæ*. The most abundant species are common to both sorts of beds.

It is also in the schistose limestones, or in the laminated marly limestones, that all the scattered fragments of fruits or leaves belonging to deciduous plants of European physiognomy have been met with, with the exception of *Ulmus plurinervia* and of a strobile of *Alnus antiquorum* (the leaves of the latter species were probably persistent). It is therefore probable that most of these plants (that is to say, the genera *Betula*, *Populus*, *Ribes*, *Acer*, *Paliurus*, and *Cratægus*), without inhabiting the margin of the water, occurred in a station within easy access of the ancient shore, and that they were associated rather with the *Coniferæ*, *Proteaceæ*, and *Leguminosæ*, than with the *Quercus*, *Andromedæ*, *Cinnamoma*, and *Anacardiaceæ*, which occur more frequently in

the marly beds. It is true that we only advance this opinion as a conjecture; there exists, however, if we attend to the preceding indications, a certain probability for the belief that the species with deciduous leaves, at the epoch of the gypsum of Aix, inhabited a station intermediate between the immediate margin of the waters and the more distant parts of the interior of the country.

With regard to the mode of grouping, that is to say, the manner in which the individuals of this series of plants was distributed, the same reasons which have inclined us to think that they were not situated on the margin of the waters, or in the inundated and marshy parts, lead us equally to believe that they did not form colonies of individuals or numerous and frequently repeated associations; the rarity of the impressions must rather lead us to assume that these organisms were then scattered here and there, and occurred only in certain situations the precise nature of which it is impossible to indicate. In a word, these organisms nowhere formed a wood, or even a group of considerable extent, but we should have met with them from time to time as isolated plants growing under the influence of some particular exposure which protected and favoured their development.

There are not wanting examples of a similar mode of existence for trees or shrubs which, not living in society, make their appearance here and there isolatedly or in very small groups, without ever multiplying greatly.

Another circumstance may have assisted in limiting the number of impressions of trees with deciduous leaves in the flora of the Gypsum of Aix—namely, the small size of the species, which were probably reduced to the proportions of mere bushes.

It sometimes seems that the gigantic must necessarily have been the appanage of the ancient creations: one is led to see it everywhere, even in species really inferior in dimensions to their living analogues. The large size of certain Cryptogamic plants of the Palæozoic epoch, the enormous Saurians of the Secondary strata, and the no less astonishing Pachydermata of the last Tertiary epoch may have led to the notion that magnitude was, as it were, a general character of extinct organisms; but this is by no means the case. On quitting animals for plants, we quickly see that in these at least the proportions have varied according to the age and classes. There are even times in which the size of species seems to diminish in comparison to that which now exists; and this phenomenon is particularly distinct in the Gypsum of Aix. Nothing in the fragments of stems and branches, nor in the aspect of the fruits and appendicular organs, indicates anything but plants of middling size;

the ancient organs, when compared with those which correspond with them in the present day, almost always appear considerably smaller, and sometimes even very much so. The silicified trunks of Palm-trees indicate the existence of small species, of which the stem, even in the largest forms, scarcely equals that of *Chamærops excelsa* in diameter. The Pines only present slender and sparingly divided branches. The leaves of Dicotyledonous plants are almost always small, narrow, oval, elliptical, or linear; and although very large trees may have small leaves, the persistence and generality of this character cannot but raise great doubts as to the size of the individuals to which they belonged. This doubt has the more foundation as most of the *Proteaceæ* most nearly allied to species of Aix in the present order of things only form shrubs of middle size or even mere bushes.

These data may be applied to the series of species with deciduous leaves in the flora of Aix; but for them there are further reasons which would lead to the belief that they were still smaller in their dimensions than the preceding. These plants, not numerous as species, and very rare as individuals, are subordinated to organisms in which the variety of combinations and the profusion of forms indicated a development arrived at its climax; it is among these that we must of course find the strongest species of the epoch. It appears to us more probable, in fact, that we should find the arborescent organisms of that period amongst the groups as to the preponderance of which there is no question, such as the Palms, *Proteaceæ*, *Laurineæ*, *Anacardiaceæ*, and *Leguminosæ*, than amongst the scarce plants with deciduous leaves, which had so inconsiderable a part to play. Considered in themselves, these species, by the knowledge we possess of their organs, confirm the supposition that they only attained to small dimensions. If we except *Alnus antiquorum*, the leaves of which were probably persistent, like those of *A. nitida* and *A. Nepalensis*, and *Cercis antiqua*, which only differs from its living congener in the outline of its leaves, the appendicular organs of the other species with a European physiognomy, either by their comparative smallness or by the analogy of the forms which correspond with them at present, indicate rather shrubs than true trees. There can be no doubt in this respect with regard to the *Ribes*, *Cratægus*, and *Paliurus*, which are only bushes. But, among others, *Betula gypsicola* belongs to a section of the genus which contains species of very small size, and which is characterized by Regel, the author of the Monograph of the Betulaceæ, as "Frutices plerumque humiles;" *Populus Heerii* is remarkable for the smallness of its narrow saliciform leaf, beyond any existing *Populus* of the section *Balsamea*, to which it

seems to belong; the *Acer ampelophyllum*, as to the true nature of which there is still much doubt, especially in the absence of its fruit, would take its place, judging from its leaf, among the smallest species of the genus.

Thus there would remain only *Ulmus plurinervia*, the leaf of which is of tolerable size, and which, even without this indication, might have constituted an actual tree. For this, its probably distant station may sufficiently explain the rarity of its impressions.

To sum up,—in spite of obscurities which it is impossible entirely to elucidate, it is certain that nearly the whole of the organisms with deciduous leaves in the flora of Aix indicate limited dimensions, denoting mere shrubs; and if there were trees among them, this denomination could only be applied to the smallest number, and, so to speak, to a single species.

We terminate these considerations, which have been perhaps treated at rather too great a length, but in which the novelty of the subject necessitated more development than in ordinary cases, by formulating our conclusions as follows:—In accordance with all the indications, it is extremely probable that the plants with deciduous leaves of the flora of Aix only played in it a secondary part; and if their impressions are very rare in the beds formed at that epoch, their station at a little distance from the ancient shores, their distribution as isolated individuals, and the small size of most of them have concurred to produce that result. We affirm, lastly, that the periodical fall of the leaves in these species, far from implying the existence of a cold season, is a phenomenon very reconcilable with the high temperature which is indicated by the profusion of tropical forms in the flora of the Gypsum of Aix.

XXX.—*Remarks on the Rev. S. Haughton's Paper on the Bee's Cell, and on the Origin of Species.* By Alfred R. Wallace.

My attention has been called to the paper in the 'Annals' for June last on the above subjects, the author of which seems to me to have quite misunderstood and much misrepresented the facts and reasonings of Mr. Darwin on the question. As some of your readers may conclude, if it remains unanswered, that it is therefore unanswerable, I ask permission to make a few remarks on what seem to me its chief errors.

Mr. Haughton combats the views not only of those who believe that the regular structure of the Bee's comb can be accounted for through the agency of "natural selection" and variation, but also of the opposite school, who impute to the Bee a super-